MINIATURE PORTABLE 8-DIGIT 250 MHZ

FREQUENCY COUNTER MODEL 585

Instruction Manual

DATA PRECISION

. . . years ahead

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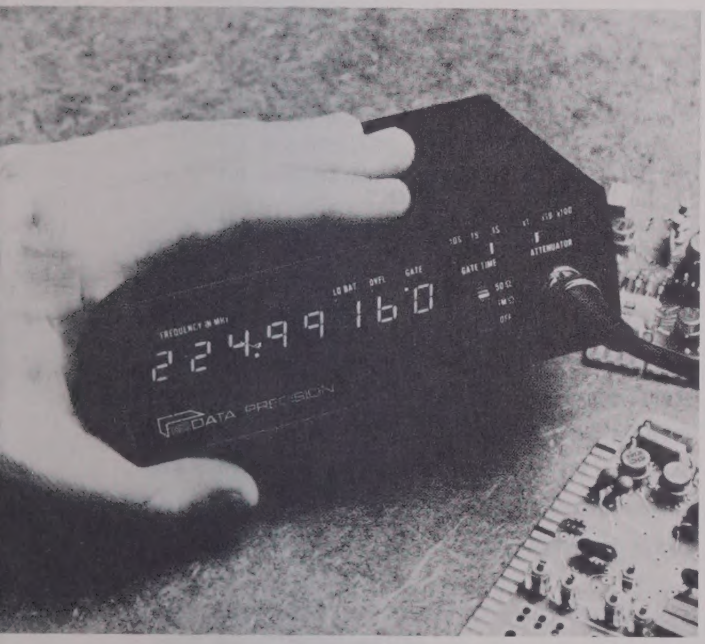

Frontispiece Model 585 Portable Frequency Meter

NOTICE

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Chapter 1
INTRODUCTION & SPECIFICATIONS

1.1 GENERAL

Data Precision's new Model 585 Frequency Counter (Frontispiece) is a miniature, portable, high frequency counter, in the same small package as the company's widely used, low cost portable multimeters. The Model 585 is an 8-digit, 250 MHz, direct measuring and direct reading frequency counter, with 10 mV sensitivity, precision crystal accuracy, and with wide range and application flexibility.

1.2 PERFORMANCE FEATURES

The hand-held Model 585 provides users with a number of performance-enhancing features.

- Direct reading and direct counting up to 250 MHz without any pre-scalers, add-ons, or extras.
- Automatically positioned decimal point for resolutions of 10 Hz, 1 Hz, or 0.1 Hz with front panel selectable gate times of 10 seconds, 1 second, or 0.1 second, respectively.
- 4 hours of continuous full performance operation from a fully charged internal battery module.
- Continuous recharging of the battery when ac-power is connected via a standard (no extra) line-cord charger unit, whether or not the instrument is in use.
- Convenient matching to high or low source impedances with front-panel switchable input impedance of 50 ohms or 1 megohm.
- Wide amplitude range of input signals accommodated by using front-panel switch selectable attenuations of unity, x10, or x100.
- Stable, jitter-free readings when normal mode noise components of the input signal may be front-panel attenuated below the 10 mVRMS sensitivity threshold up to 50 MHz, and below 50 mVRMS to 250 MHz.
- Portability and operation in rugged environments, assured by Model 585 small size (5½" × 1¾" × 3½), light weight (less than 1¼ lb.), and high impact-resistant plastic case with internal battery module.
- Reliable, long-life performance, achieved by reduced-parts-count design, using cool-running, low power, LSI chips and standard, proven solid state devices.

• Standard high-accuracy performance, obtained by using a crystal-controlled time base generator circuit specified to ±4 ppm/year and ±5 ppm over the temperature range of 0 to 40°C. Optionally, even greater accuracy and wider thermal range stability is easily obtainable by replacing the standard plug-in crystal-controlled time base generator circuit with a premium temperature compensated time base generator with ±1 ppm over the 0 to 40°C range and only ±1.5 ppm/year aging drift.

• Reliable performance from measurement-to-measurement, obtained by the short-time stability of the standard crystal of ±0.01 ppm/sec, providing repeatable measurements, even to the least significant digit of the 8-digit display.

• Absolute accuracy settable to ±0.01 ppm.

1.3 SPECIFICATIONS

Frequency Range:	10 Hz to 250 MHz.
Display:	8 digits, 0.3″ LED; Decimal point, automatically positioned; Gate indicator; Overflow indicator; Low battery voltage indicator.
Sensitivity:	10 mVRMS, 20 Hz to 50 MHz; 50 mVRMS, 50 MHz to 250 MHz.
Gate Times:	.1 sec, 1 sec, 10 sec.
Resolution:	10 Hz, 1 Hz, 0.1 Hz.
Input Impedance:	50 Ohms, 1 Megohm
Input Attenuator:	x1, x10, x100.
Accuracy:	± (1 count + Time Base Accuracy)
Time Base*:	Frequency: 6.5536 MHz. Accuracy: ± 0.01 ppm/sec; ± 0.6 ppm/mo; ± 4.0 ppm/yr; Tempco: ± 5.0 ppm/(0 to 40°C). Power Supply: < 0.1 ppm/Volt.
Maximum Input Levels:	@ 50 ohms input impedance: 500mW; (5 VRMS) @ 1 Megohm input impedance: DC to 10Hz: 200 VRMS 10 Hz to 100 KHz: 250 VRMS 100 KHz to 5 MHz: 2.5×10^7 V × freq. 5 MHz to 250 MHz: 5 VRMS

Temperature:	Operating: 0° to 40°C; Storage: −25° to +50°C.
Size:	5½" × 1¾" × 3½"; (1398 mm × 460.2 mm × 904.7 mm).
Weight:	1¼ lb; < 3 lb packed for shipment.
Power:	4-cell NiCad battery module, rechargeable; Charger and integral line cord**; 4 hours continuous operation when fully charged; < 1 watt battery operation; < 1.4 watts from ac line when operating while charging.
Carrying Case:	Vinyl, fitted with charger.

* Premium time base available (TB4)

**Battery Charger L85 (105 V to 125 VAC) furnished for Model 585
Battery Charger L90 (210 to 250 VAC) furnished for Model 585E.

1.4 OPTIONS/ACCESSORIES

The following options and accessories are available to extend the performance capability of your Model 585. Consult the local distributor. Order by Accessory Number.

Item Description	Accessory Number
Input Cable: 5 ft, BNC/BNC, 50-ohm	BN85
Bench Stand	B40
Whip Antenna	AN10A
Leather Carrying Case	WE8
Fiberglass Carrying Case	FC9
Panel Mount Adaptor	R36
Battery Module	C75
Battery Charger (105–125 VAC)	L85
Battery Charger (210–250 VAC)	L90
High Accuracy Time Base	TB4

Chapter 2
OPERATION & RECALIBRATION

2.1 GENERAL

Model 585 Frequency Meter has been shipped with a fully charged battery pack, and should be usable immediately upon opening the carton and attaching a suitable probe lead. This chapter contains:

(a) An inventory list of what you should find when opening your packing carton;

(b) A complete description of the operating controls and indicators;

(c) Step-by-step procedures for operating the instrument;

(d) Step-by-step procedures for recalibrating the instrument when necessary; and

(e) Application notes to help you obtain the measurement accuracies of which the instrument is capable.

2.2 UNPACKING & REPACKING

Model 585 is shipped in a molded foam plastic protective fitted container. The documentation set is packed in a recess at the top of the outer protective container. The complete shipment contains the following items:

(a) Model 585 8-Digit Counter with wrist strap attached and battery pack module installed;

(b) Line cord with attached battery charger unit; Charger L85 for 105–125V power mains and Charger L90 for 220–250V power mains.

(c) Vinyl carrying case;

(d) Certificate of Conformance;

(e) Copies of authenticated Factory Test Data Sheets;

(f) Warranty Card;

(g) Instruction Manual;

(h) Molded plastic container and dessicant.

Carefully inspect these articles, noting especially the matching serial numbers of the instrument and the test data. Inspect the packing carton and the packed items for signs of damage or abusive handling during shipment and report immediately to the carrier. Fill out and return the warranty card to register your instrument and to establish the warrantied service interval.

Any ordered accessories, such as bench stand, spare battery module, or charger module are shipped in their own containers.

When shipping the instrument, place it in its vinyl carrying case and in the protective molded container; pack in original shipping carton if available. If original carton is no longer available, wrap the instrument with a foam type insulation or air bubble plastic and pack in a suitable carton. Use sufficient stuffing to keep the unit securely positioned in the carton.

If Model 585 is to be stored without use for any appreciable time (6 months or more), the batteries should be recharged every 6 months to prolong battery life.

2.3 READYING FOR USE

Read this chapter and become acquainted with the operating procedure, especially the cautions and warnings, before attempting to use your instrument.

The Model 585 Counter is shipped with a charged battery module installed. If there has been an extended interval between shipment and use, check the battery by operating the Impedance switch to the 1MΩ position and checking for LO BAT indication in the display. If there is a LO BAT indication or no display at all, then insert the charger output plug into the Model 585 jack and connect charger to appropriate line power. The LO BAT indicator should go out if checked after approximately 15 minutes of charging time, and the battery should be fully charged in 12 hours, if the module was completely discharged at start of the charge cycle.

The instrument many exhibit certain battery performance below rated characteristics that are only temporary operational effects typical of battery usage patterns. Such below-specification performance can be corrected easily and in a minimum of time.

Memory. If the instrument is used in a series of repeated partial charge and discharge cycles that use only a small portion of the available battery capacity, the battery will become conditioned to deliver only slightly more than normal end-of-discharge voltage capacity when called on to perform in an extended discharge cycle.

To correct this condition, subject the battery to a deep discharge, and then recharge to full capacity. This will erase the "memory" pattern.

Sustained Overcharge. If the instrument is kept on "high voltage charge" for long periods of time without discharge interruptions, the battery may not deliver normal voltage at the end of the first sustained discharge operation thereafter.

To correct, proceed as for the memory effect described above; discharge the battery, then recharge to full capacity.

2.4 CONTROLS & INDICATORS

2.4.1 Front Panel — See Table 2-1 and Figure 2-1.

2.4.2 Rear Panel — See Table 2-2 and Figure 2-2.

Table 2-1
FRONT PANEL CONTROLS & INDICATORS

FIG REF	NAME/DESCRIPTION	FUNCTION
1	Display/ 8 planar 7-segment LED digits; automatically positioned decimal point	Indicate measured frequency, direct reading in MHz.
2	Power-Impedance slide switch (OFF-1MΩ-50Ω)	Connects battery to internal power supply; selects either 1MΩ or 50Ω input impedance.
3	Input Connector (BNC)	Connects measurand input to Counter circuits.
4	ATTENUATOR/ slide switch (x1-x10-x100)	Selects input signal attenuation factor.
5	GATE TIME slide switch (10S-1S-.1S)	Selects time interval over which counter input is gated. Positions decimal point in display.
6	GATE indicating LED	Is on when gate is opened.
7	OVFL indicating LED	Is on when counter exceeds 99999999.
8	LO BAT indicating LED	Blinks when battery voltage drops below pre-set threshold value (nominal 4.8V).

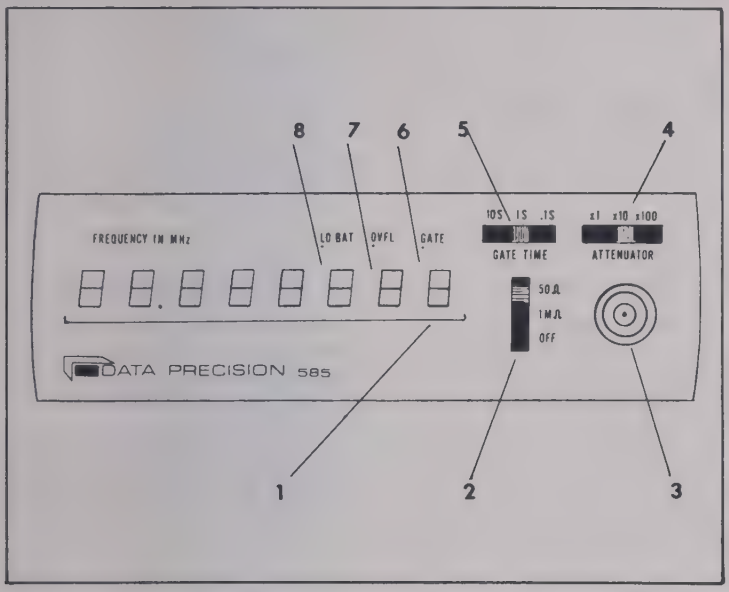


Figure 2-1 Model 585 Front-Panel Controls and Indicators.

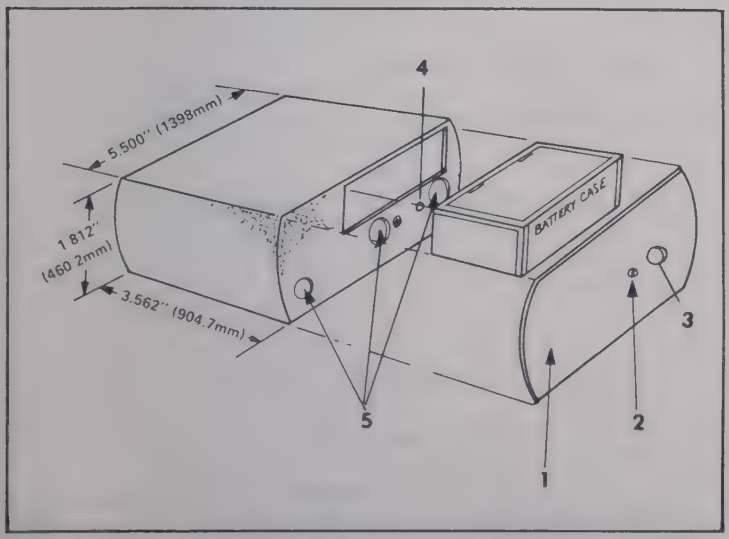


Figure 2-2 Model 585 Outline dimensions and Rear-Panel controls.

Table 2-2
REAR PANEL CONTROLS

REF	NAME/DESCRIPTION	FUNCTION
1	Rear Cover	Removable protective cover; permits access to calibrating adjustments and to battery module assembly.
2	Fastening Screw	Holds rear cover in place
3	Charger Access	Access hole for charger plug.
4	Charger Input	Jack receptacle for input from charger.
5	Adjustments Access	Access to 3 rear-panel accessible adjustments.
	R9	Balances input offsets (OFFSET)
	C204	Adjusts time base (ACCURACY)
	R203	Adjusts battery sensing (LO BAT)

2.5 OPERATING PROCEDURES

If measurement is to be made with battery supply only, first check for adequate battery charge as explained in paragraph 2.3.

CAUTION

When exact nature of input signal is unknown, it is recommended that all measurements be started with 1MΩ input impedance and x100 ATTENUATOR positions.

(a) Connect measurand input signal to input with mating male BNC connector.

(b) Operate Power-Impedance switch to 1 MΩ or 50Ω position as appropriate.

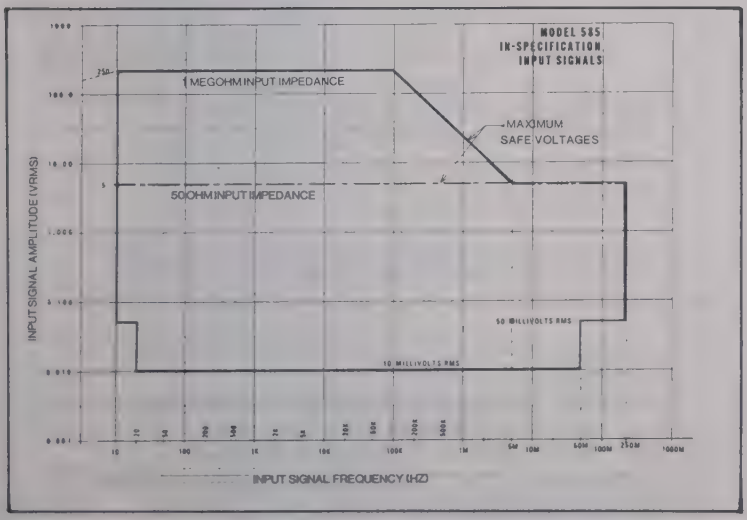
(c) Operate ATTENUATOR switch to x100. If signal is low level (and display is unstable) change ATTENUATOR to x10 or x1, as appropriate.

(d) Operate GATE TIME switch to position providing best resolution of frequency to be measured. Refer to Table 2-3 for appropriate GATE TIME settings. Use lowest practicable GATE TIME value to obtain measurements rapidly; 10 sec gate yields best resolution; .1 sec gate yields fastest measurements.

(e) Read display directly in MHz. See Figure 2-3 for input signals (amplitude and frequency) where in-specification performance of Model 585 is obtained.

2.6 RECALIBRATION

Model 585 has been designed to perform within specification accuracy as determined by the specified drift of the time base oscillator (0.6ppm/mo and 4ppm/year). When the possible uncertainty introduced by the time lapse since last calibration exceeds the desired degree of accuracy for the particular applications [for example, ±(4ppm + 1 l.s.d.) at 1 year], then the Counter should be recalibrated as described in the following paragraphs. If recalibration does not clear the symptom, refer to Chapter 4, Maintenance, for further instructions.



2-3 Model 585 Input Amplitude-Frequency Specifications

Table 2-3
GATE TIME SELECTION & DECIMAL POINT POSITION

FOR INPUT FREQUENCIES	SELECT GATE TIME	DECIMAL POINT POSITION & TYPICAL DISPLAYS
10 Hz to 9.9999999 MHz	10S	0.0000508 (50.8 Hz) (0.1 Hz Resolution) 0.0001000 (100.0 Hz) 0.0010000 (1.0000 KHz) 5.5000000 (5.5 MHz)
10 MHz to 99.999999 MHz	1S	15.500000 (15.5 MHz) (1 Hz Resolution) 55.000000 (55 MHz) 99.000000 (99 MHz)
100 MHz to 250 MHz	.1S	199.90000 (199.9 MHz) (10 Hz Resolution) 245.00000 (245 MHz)
100 MHz to 250 MHz	1S	99.900000 (199.9 MHz with 1 Hz resolution) Note that the overrange indicator is lighted, and the leading decade value is inferred (not displayed)

NOTE

Calibrating Operations are totally non-interactive. They may be performed in any sequence, and only those parameters in need of adjustment need be modified at any one time.

(a) Calibrating Test Equipment. Test standards and measuring equipment with performance specifications equal to or better than those shown in Table 2-4 should be used when calibrating Model 585.

(b) Low Battery Sensing. If the front panel LO BAT indicator operation appears not to respond correctly for the known battery condition (blinks for a known good battery voltage, or does not blink for a known poor battery voltage) check and adjust as follows:

(1) Remove battery module assembly; slide from case.

(2) Connect DCV power supply to the spring clip battery terminals. See Figure 2-4.

Table 2-4
CALIBRATING TEST EQUIPMENT

FUNCTION	PERFORMANCE SPECIFICATIONS	MFG/MODEL	M/G*
DCV Power Supply	4.5V to 6.0V ±0.5% @ 300mA	TRYGON/DL40-1	G
RF Signal Generator	Frequency Range 1 MHz to 250 MHz ±1ppm Amplitude 0 to 100 mVRMS	BOONTON/102B FM-AM SIGNAL GENERATOR	G
DCV Digital Multimeter	0 to 10V ±0.1%	DATA PRECISION/ Model 245	M
Oscilloscope	Wideband to 50 MHz	TEKTRONIX/485	M

*M = Measuring; G = Generating

WARNING

Take extreme care to connect proper polarities of dc power to circuit. Incorrect polarity connection can cause severe damage to the instrument.

(3) Adjust DCV supply for a voltage of +4.8V to the clips.

(4) Turn Model 585 on by operating Power-Impedance switch to the 1 MΩ position.

(5) Adjust R204 so that LO BAT indicator just begins to blink.

(6) Increase applied voltage to 4.9V and verify that LO BAT indicator turns off.

(7) Turn off Model 585; remove DCV power; reassemble into case; reinstall battery assembly.

(c) Master Oscillator Frequency Adjustment (Accuracy). If the indicated measurement is evidently incorrect (although stable) and the power supply appears to be proper (no LO BAT indication or on charger operation), check and adjust as follows:

(1) Use charger-applied power.

(2) Connect an input signal from the RF Signal Generator. Adjust the generator for a signal output of 100 mVRMS (approx.), and a frequency of 50.0 MHz within the specified input region. See Figure 2-3.

The particular frequency selected is unimportant; its value should be known precisely.

(3) Operate the ATTENUATOR switch to the x1 position.

(4) Select IMPEDANCE for appropriate match to RF generator.

(5) Select GATE TIME of 1S.

(6) Adjust C204 so that displayed value is the same as the known input frequency.

(d) Input Sensitivity (BALANCE). If the indicated measurement appears unstable, although the input signal is within the specification limits and above the threshold level for proper operation (and the appropriate impedance selection has been made), check and adjust as follows:

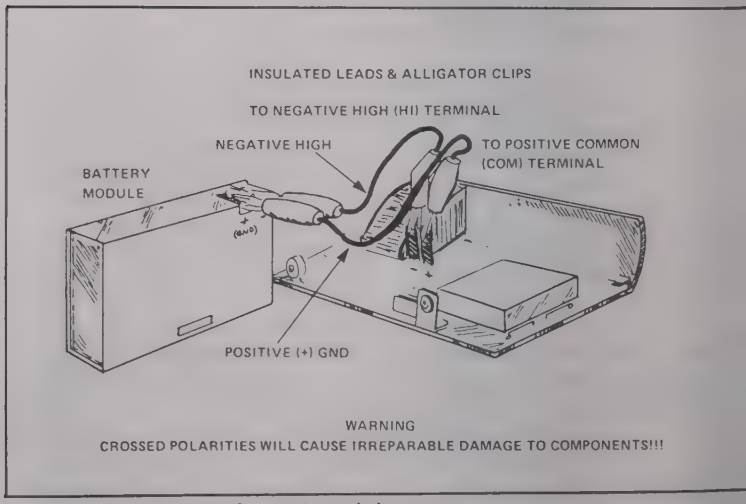
(1) Use charger-applied power.

(2) Connect an input signal from the RF generator. Adjust the generator output for a signal of approximately 50 MHz at an amplitude of 10 mVRMS.

(3) Select a GATE TIME of .1S, ATTENUATOR of x1.

(4) Adjust R9 until display becomes stable and accurate.

(5) Remove input; turn power OFF.



2-4 Connecting external dc power

Chapter 3
PRINCIPLES OF OPERATION

3.1 GENERAL

Model 585 Frequency Counter provides 8 full decades of displayed count for input signals within the specified Amplitude-Frequency region and scales the result by automatically positioning the decimal point so that the value is direct-reading in megahertz. The decimal point is positioned with the selection of 0.1, 1, or 10 seconds gate time. Input signals are connected via a front-panel mounted BNC connector, and the displayed count appears on 7-segment planar LED digits. In addition to the decimal point, the display also includes indications of the operation of the gating circuit, low battery voltage, and overflow of the counter (greater than 99999999). The portable counter may be powered solely from its integral battery module, or from the line-charged battery when the charger is connected.

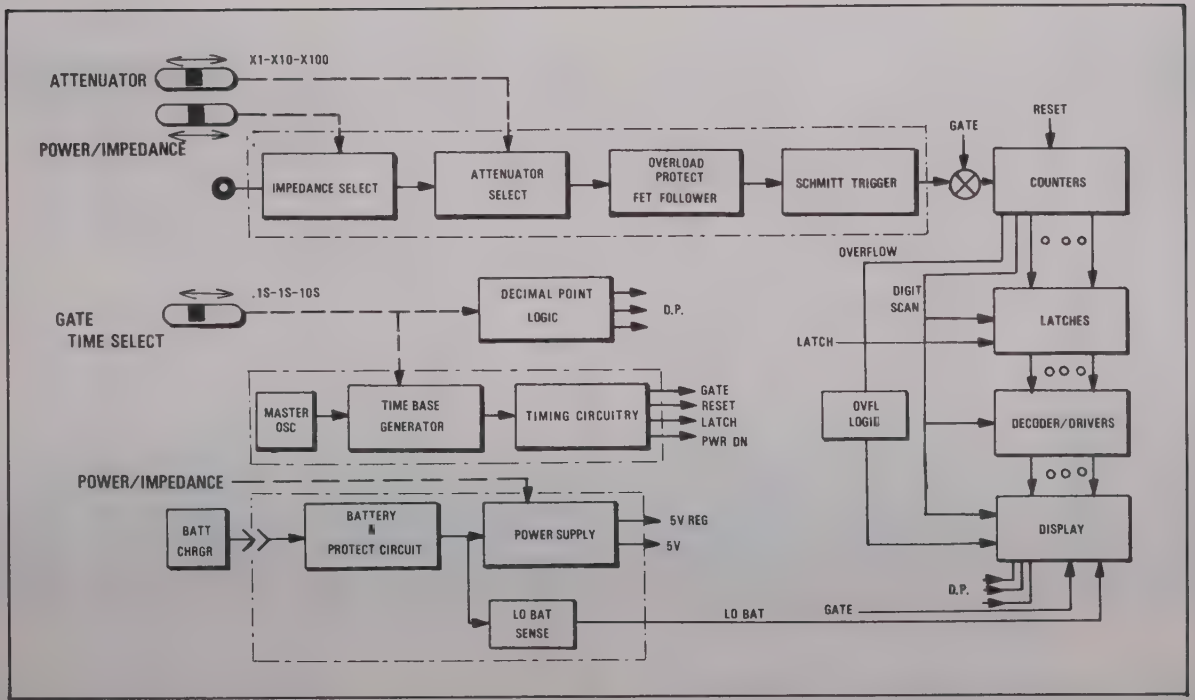
3.2 FUNCTIONAL BLOCK DIAGRAM

As shown in Figure 3-1, Model 585 consists of 5 major blocks performing the following functions:

(a) Input signal conditioning
(b) Timing circuitry
(c) Counting and latching registers
(d) Multiplexed decoder drivers and display elements, and
(e) Power supply generation.

The input signal conditioning circuit operates on the connected input to develop a train of squared-top pulses of uniform amplitude to be gated into the counter. Input impedance of 50Ω or 1 MΩ may be selected (front panel control) as appropriate for the signal source. This circuit also includes a front panel selectable attenuation of 1, 10, or 100 so that high amplitude signals (up to 250 VRMS at 1 MΩ input impedance) may be measured while any low level noise riding on the waveform is attenuated below the triggering threshold. And, finally, the circuit contains a Schmitt trigger with automatically adjusted threshold sensitivity to produce the train of pulses to be counted during the gated timing interval.

The timing circuitry contains a crystal-controlled master oscillator circuit from which is derived control signals that:



3-1 Model 585 simplified block diagram

(a) Reset the counter prior to each measurement
(b) Gate the input to the 8-decade counter
(c) Latch the count output at the end of each gated interval, and
(d) Remove power from the power-consuming LSI chip between counting intervals so as to conserve battery power.

The gated time interval is front-panel selectable to 0.1, 1, or 10 seconds. The non-counting interval is always 0.1 seconds. Thus, power duty-cycles of 0.50, 0.90 and 0.99, respectively, are obtained for the power-consuming IC component, and the most efficient battery use is obtained at a gate time of 0.1 seconds.

The counting circuits accumulate the count in 8 decades over the time interval that the gate is "open". The accumulated count is transferred into latching registers at the end of each gated interval, from which the values are multiplexed to the decoder-drivers and thence to the display.

The multiplexed decoder-drivers translate the BCD codes for each digit into corresponding 7-segment display drivers under control of digit-scan signals that synchronize the selected digit value with the powering of the corresponding display digit. The 8 digits are time-shared in pairs; each digit-scan signal addressing two decade values, and completing the power circuit to the appropriate display digits.

The power supply circuit consists of a 4-cell NiCd battery assembly from which power is front-panel switchable to the Model 585 power supply circuits. Raw battery voltage is connected directly to the logic circuits, while a regulator circuit develops regulated +3V for the analog signal conditioning circuitry. In addition, the power supply contains the battery voltage sensing circuit that generates a low battery display indication. A battery charger with integral line cord may be plugged into the counter, and it will charge the battery at all times that the charger is connected to the appropriate power. The battery module must be connected in the circuit at all times to provide the proper loading on the charger. The power supply circuit includes switchable load so that the battery is charged at a constant rate whether or not the Model 585 is operating.

3.3 INPUT SIGNAL CONDITIONING

The input signal conditioning circuits include discrete components and part of an LSI chip. Some of these are mounted on the front-

panel display assembly for minimum wire runs to front-panel input connector and operating controls. The remainder are mounted on the main pc-board assembly. Shielding elements are installed in the front panel and on the main pc-board to reduce interference. Refer to the circuit schematic at the back of this manual in conjunction with the explanatory text that follows.

Front panel switch S101 is a three-position slide switch with OFF-50Ω-1MΩ positions. In the OFF position, S101 disconnects battery power from the counter. In the 50Ω position, 51Ω is connected across the input, providing an equivalent 50-ohm input impedance. In the 1MΩ position, the 51Ω resistor is disconnected from the circuit, leaving the 1MΩ in series with 0.01μF input impedance across the BNC connector.

Front-panel ATTENUATOR switch S102 is a three-position slide switch, with x1, x10, and x100 positions. In the x1 position, the full amplitude of the input signal across R103, R104, and R105 is connected to the counter input. In the x10 position, one-tenth the input signal is transmitted and in the x100 position, one-one hundredth the input signal is transmitted to the remainder of the circuit. The voltage divider of R103, R104, and R105 is frequency compensated by capacitors C103, C104, and C105.

The attenuated (or straight through) signal is limited by CR1 and CR2 to an amplitude of about 1 volt peak-to-peak before connection to Q1 which is configured as a FET follower. Transistor Q3 is the current source for the FET, followed by emitter follower Q2, whose output is capacitor coupled to Z5. The resistance network A2, adjusted by R9, is used to balance internal offset of the differential amplifier so that the counter input signal will operate into a net balanced input for improved sensitivity.

Z5 also contains the trigger circuit, counting gate, and the first decade of the counter chain. The external circuitry of Q5, R10, R11, C8, and the overflow control signal are connected so that the trigger threshold sensitivity is automatically adjusted in a "feed forward" arrangement whereby the initial threshold is relatively high while succeeding thresholds are low. This circuit design improves the capability of the instrument to respond with accurate readings to marginally low input signals.

3.4 COUNTER, LATCHING REGISTER, & DISPLAY

IC's Z5, Z6, Z7A, Z7B, and Z8 comprise an 8-decade counter chain. BCD outputs of each of the four lower decades are independently latched into registers Z3A, Z3B, Z4A, and Z4B, while the four higher decades and latching registers are incorporated in LSI chip Z8.

The carry from the eighth decade.(MSD) clocks flip-flop Z9A

when an overflow occurs (count exceeds 99999999) and is clocked through flip-flop Z9B for overflow display when Z9B is clocked by the LATCH control signal. The RESET signal removes the overflow on Z9A at the start of each counting cycle, but does not affect the display until the next count is complete.

Z8 also contains the scan oscillator that develops address control signals to multiplex the four decades in the Z8 chip and are also used in parallel to multiplex the four lower decades.

Latching of the count in the four more significant decades is accomplished internal to the circuitry in Z8. For readout of the latched data, Digit Scan addresses are properly timed with respect to the BCD data appearing on terminals 14, 15, 16 and 1 of Z8. Latching signals for the four lesser decades are in parallel under control of the LATCH control (see para. 3.5). Read out of the latched data in these registers (Z3A, Z3B, Z4A, and Z4B) is accomplished by developing an enabling signal from the respective digit scan signal. In effect, 3 of the latches are disabled, while the appropriate one for the display digit being powered is not disabled.

The 8 display digits are powered in four pairs corresponding to the decade values addressed by the control signals from the scan oscillator.

Display digits DS101 through DS104 are addressed in series-parallel with digits DS105 through DS108 by the address commands generated in Z8. The address control signals turn "on" transistors Q101 through Q108 to complete the power circuit for the respective display digits. Decoder driver Z1 translates the BCD code for the four lesser decades into equivalent 7-segment drives, while Z2 accomplishes the same function for the four major significant digits.

The decimal point display circuit applies - 5V to the LED indicator corresponding to the selected GATE TIME. The "A" section of switch S103 determines which point will be turned on. For .1S, the switch connects + 5V through a 240-ohm resistor of network A5 to the LED in DS106. For 1S, the same resistor load is used to connect to DS107. For 10S, the LED in DS108 is driven through transistor Q103.

3.5 PROGRAM CONTROL

Program control signals are developed from a master oscillator circuit containing crystal oscillator Y201 configured in a tunable circuit containing FET Q203 and variable capacitor C204. The tuned output of 6.5536 MHz is transformed to TTL levels via Q201 and Q202 to drive the selectably configured counter circuit consisting of Z201, Z15, Z14,

and Z13. The counter circuit is configured by the positioning of front-panel GATE TIME switch S102 so that the GATE duration is the selected value. Z201 is a divide-by-16 unit, Z15 is a divide-by-10 unit, Z14 is a dual divide-by-10 unit, while Z13 is used as a divide by 2^{13} unit.

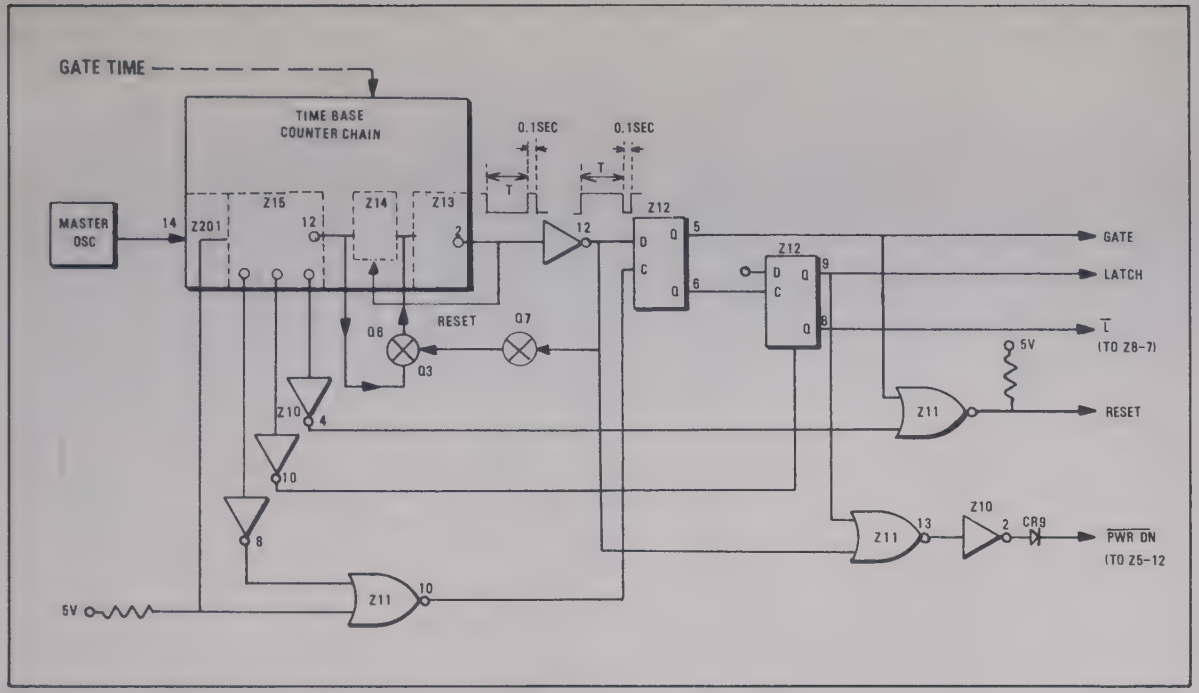
For a 0.1 second gate interval, the output of Z15 is connected as input to Z13 (by-passing Z14). Thus, the output at Z13-2 is $(6.5536 \times 10^6) \div 16 \div 10 \div 2^{13} = 5$ Hz. The output at Z13-2 in this instance is a 5 HZ signal, inverted by Z10-12, and applied as the "D" input to flip-flop Z12-2. (Note that each half cycle is 0.1 second.)

For a 1-second gate interval, the counter chain inserts one of the divide-by-10 sections of Z14, providing a nominal .5 Hz output of Z13-2 (until the action of Q3 is considered); and for a 10-second gate, a nominal .05 Hz, with half cycle times of 1 second and 10 seconds, respectively.

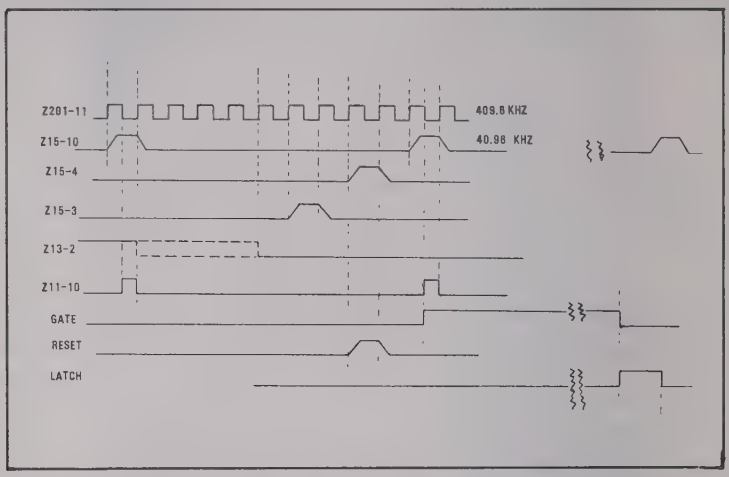
The count accumulated in the 8 decades during the selected gate interval of 0.1, 1, or 10 seconds is scaled in the display to be read directly in megaherz by automatic positioning of the decimal point. Clearly, a 1-second gated interval requires 6 decades to the right of the decimal point; merely dividing the accumulated count which represents Hz by 10^6 to change to MHz. A 10-second gate will accumulate 10 times as many counts for the same input, and the decimal point must therefore be shifted one more place to the left. With a 0.1 second gated interval there will be one-tenth as many counts for the same frequency input, and the decimal point should be moved one place to the right, relative to the 1-second count. The decimal point position is determined by the action of slide switch S102, connecting +5V to the proper indicating LED through elements of network A104, A105, and transistor Q109.

Initializing the counter, starting and stopping the counting action, and transferring the count to the display are determined by the states of control signals RESET, GATE, LATCH, and ADDRESS. The RESET signal sets the counter decades to zero; the GATE signal inputs the Schmitt trigger output to the counter chain for as long as the GATE level is high; the LATCH transfers the count to the registers; and the ADDRESS signals multiplex the BCD decade values to the decoder drivers Z1 and Z2. The 7-segment translations of the BCD values actuate the display digits (2 at a time) as addressed under control of the SCAN output of Z5.

Figure 3-2 is a simplified block schematic of the circuit that develops the program control signals from the Master oscillator. Timing relationships among the control signals are shown in Figure 3-3. Both illustrations should be referenced in the circuit operations described in the following paragraphs.



3-2 Model 585 Program control signal generation



3-3 Program control signals timing relationships

As shown in the illustrations, the negative-going output of Z13-2 initiates the GATE sequence (but not the gating action as will be seen later). The output of Z13-2 will remain low for the duration of the selected GATE TIME, as determined by the setting of switch S103 and explained earlier. When the Z13-2 output goes high, the negative output of Z10-12 actuates a switching action of Q7 and Q6 that connect the output of Z15 to the input of Z13 (it is also connected in this configuration for the .1 second GATE TIME). Therefore, the Z13-2 output remains high for only as long as a carry is propagated through the counter by the 40.9 KHz input — or .1 seconds; and the inter-measurement interval is thus independent of the selected GATE TIME interval. The high level output of Z13-2 acts to RESET Z14 during the intermeasurement time to assure that it starts in synchronism at zero at the next measurement.

Divide-by-10 counter Z15 also provides a number of delayed outputs, some of which are used to control precisely the relationships among the program control signals. As shown in Figure 3-2, the Z13-2 output, after inversion, is the "D" input to a flip-flop that is clocked by one of the delayed outputs from Z15; the LATCH is developed from another flip-flop that is clocked by the Gate flip-flop and is itself reset by another of the delayed signals from Z15; while the RESET signal is gated through Z11-7 by still another of the delayed signals from Z15. As shown in Figure 3-3, RESET is accomplished in one cycle (409.6 KHz) just prior to GATE; LATCH commences at the end of GATE, and is completed before the start of the next RESET.

Note the two complementary outputs of Z12 identified in Figure 3-2 as LATCH (Z12-9) and L (Z12-8). The former latches the registers in Z3A, Z3B, Z4A, and Z4B, while the latter is used in Z8.

3.6 POWER SUPPLY

Model 585 circuitry operates from a +5V supply. Raw +5V (nominally 4 × 1.3 = 5.2V) is supplied directly from the battery module or from the line-charged battery when the battery charger is in use. When Model 585 is turned on, and the charger is being used, the charger current is sufficient to operate the instrument and to charge the battery simultaneously. When the Model 585 is turned off (and the charger remains connected), R12 limits the charging current to the battery to a safe level.

Regulated +3V is developed in the Oscillator assembly by the circuit including reference diode CR201 and operational amplifier Z202-1. Z202-1 maintains an equality between the +2.4V level at the high side of CR201 and the voltage divider pick off point across the battery supply voltage. At equilibrium, the voltage at the output of Z202-1 is kept within ± 0.2 volts of +3.2 volts.

Comparator Z202-7 senses the difference between the CR201 level of +2.4V and the output of an adjustable divider connected across the battery supply voltage. The pick-off point of the divider is a variable determined by the setting of R203. It is nominally set so that a battery voltage less than +4.8V will cause the LO BAT indication to appear in the display. When the output of Z202-7 goes negative (low battery), it initiates the oscillator action of Z203-3, -6, and -8, causing Q204 to drive the LO BAT display as a blinking indication.

Chapter 4
MAINTENANCE

CAUTION

Your instrument is covered by a one-year warranty and should be referred to the factory for maintenance within the warranty period. Attempts to make any extensive repairs within the warranty period may invalidate the warranty. If repairs are needed after the warranty period, only qualified technicians should attempt to effect such repairs and should use test instruments and standards calibrated within the accuracy and tolerances of the specifications.

4.1 GENERAL

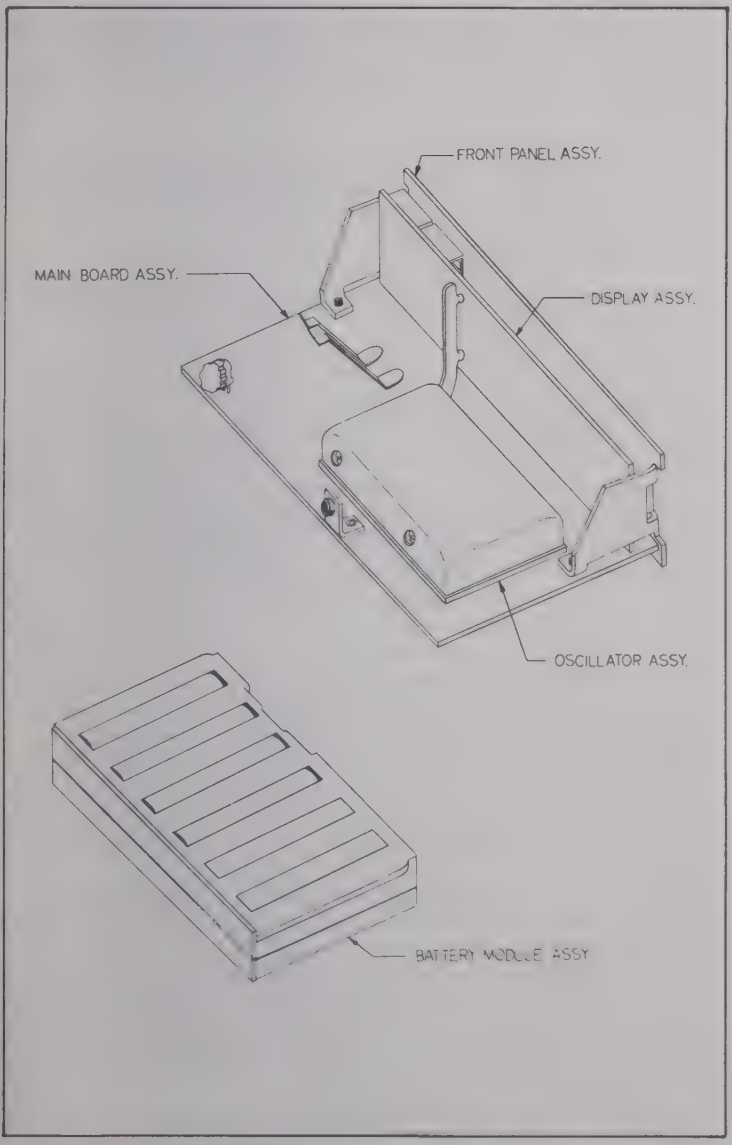
Model 585 is designed for long life, high reliable operation, utilizing a minimum parts count, solid state circuitry incorporating low-power integrated circuits, and consolidating analog and digital functions and resistor networks into single chips wherever practicable. Information furnished in this chapter is designed to assist qualified technicians in the trouble-shooting and repair process. An understanding of the principles of operation of Model 585 circuitry as explained in Chapter 3 is considered essential for rapid trouble-shooting of the instrument's malfunction.

4.2 PHYSICAL DESCRIPTION (Figure 4-1)

Model 585 consists of 5 assemblies assembled within a high-impact plastic case.They are:

(a) Main board assembly
(b) Display assembly
(c) Front panel assembly
(d) Oscillator Assembly
(e) Battery Module assembly

The display assembly is electrically interfaced with the main board assembly by solder connections. It is fastened to the main board assembly by a soldered bracket. (See Figure 4-1.) Circuit components in this assembly are referenced by symbols in the "100" series.



4-1 Model 585 Mechanical assembly

The front panel assembly is a rigid metal panel assembly. It is electrically connected to the front panel assembly by wired connections, and mechanically connected to the main assembly by two fastening screws.

The oscillator assembly, containing the master time base oscillator and components of the bias supply, plugs into the main assembly for both mechanical and electrical interfacing. Circuit components on this assembly are referenced by symbols in the 200 series.

Main PC-board circuit components are referenced by symbols in the 0 to 99 series.

4.3 TROUBLE SHOOTING STRATEGY

General. The symptom of a malfunctioning counter may be sufficient in itself to permit accurate diagnosis and repair/replacement of the defective element. Some of these symptoms are described in a later subparagraph. In general, however, it is possible to proceed in a logical manner with high probability of successfully diagnosing the difficulty in a minimum of time. This sequence encompasses the following steps:

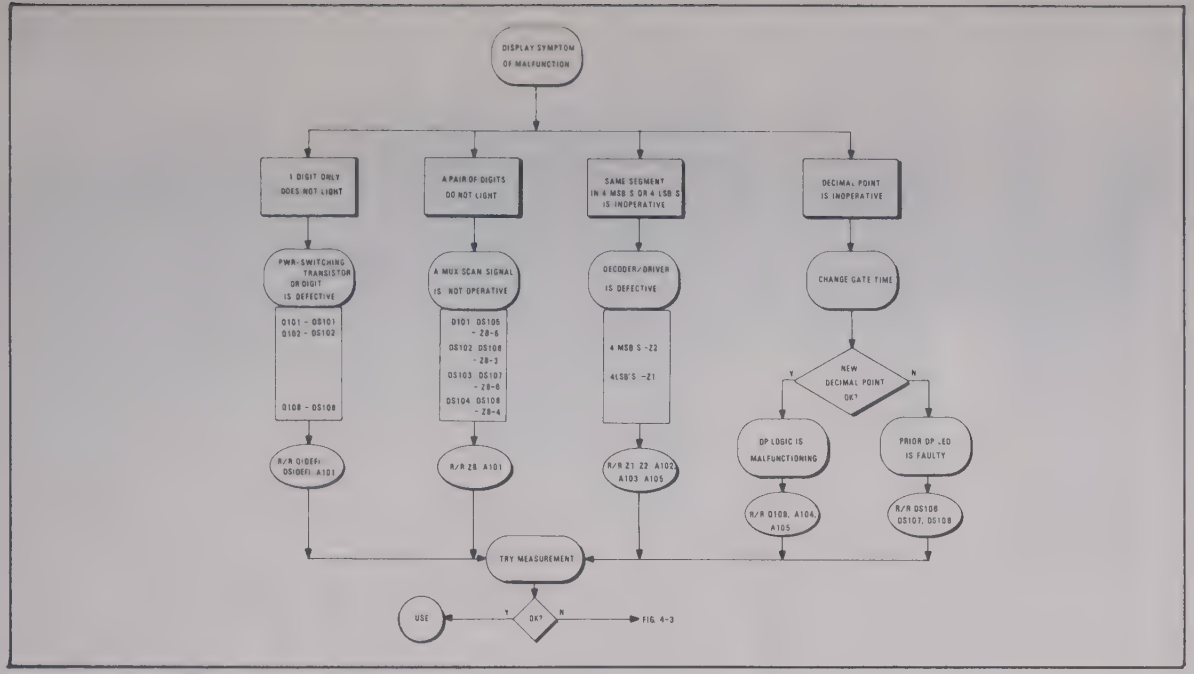
(a) Power Supply check
(b) Closed-case symptom analysis
(c) Timing circuitry check
(d) RF front-end check.

Power Supply Check. If the symptom of improper performance appears when operating on battery alone, even though the LO BAT indicator is not present, attach charger output and connect to proper ac power supply mains. (Check to see that charger is specified for the ac mains in use.) If malfunction symptom is cleared, then:

(a) Charge battery module (or replace with fully charged battery module);

(b) Perform LO BAT sensing recalibration (see Chapter 2). If symptom is still present on battery operation, the instrument requires an open-case diagnosis as described in later paragraphs.

Closed-Case Trouble Shooting. A number of display malfunction symptoms may be traced to specific component failures. These are illustrated in Figure 4-2, and the component responsible for each failure is identified in the illustration.



4-2 Closed-Case Trouble-Shooting Procedure

4. OPEN-CASE TROUBLE SHOOTING

4.4.1 General. To remove the instrument from its case:

(a) Remove the rear cover. (See Figure 2-2.)

(b) Remove the battery module assembly.

(c) Unfasten the case assembly by removing the attaching screw on the underside of the case assembly. Retain the screw.

(d) Slide out the assembled Counter by steady pressure at the rear panel.

(e) Place the instrument assembly on a non-conducting surface to prevent shorting component terminals on the underside of the main PC-board assembly. Before applying power, examine the assemblies for signs of physical damage, loose components or connections, or signs of overheating discolorations. Perform any obvious corrective actions.

4.4.2 Applying Power.

The battery assembly must be connected (whether or not the charger is used). Observe extreme caution when attaching battery power to verify that the proper polarities are connected. See Figure 2-4. When power is applied, turn Counter on, and look for signs of any overheating; touch IC components and identify any with very high temperature. (They may be warm, but should not become too hot to touch without pain.) Turn off Counter power, lift up Oscillator assembly, and check for excessive heating of IC components beneath the assembly. Check the operation of any overheated component; replace if defective. Replace Oscillator module assembly. Turn on. Check +3V Regulated output at TP1 with respect to ground. Value should be between +3.00 and +3.4V with no more than 25 mVRMS ripple. If apparent voltage error, refer to reference schematic and check circuitry associated with Z202. Check recalibration of low battery sensing circuit (refer to Chapter 2). If unable to obtain proper performance, check circuitry of Z202 and Z203.

4.4.3 Timing Circuitry.

A step-by-step procedure for checking the timing logic circuit is illustrated in Figure 4-3. It covers the generation of GATE, LATCH, and RESET control signals from their origin in the master oscillator. Waveforms at significant circuit stages may be checked easily by using the numbered test points 2, 3, 4, 5, and 6, which are identified in Figure 4-1. Operation of components hidden beneath the oscillator assembly may be checked at terminal points on the underside of the Main PC-board assembly. See Reference Dwg. Use wide-band oscilloscope and frequency counter as specified in Chapter 2 for Recalibration purposes.

4.4.4 RF Front End.

Once the programming logic is operable, the frequencies generated in these components may be used as inputs to check performance of the RF front end circuitry and the counter chain that follows it. Figure 4-4 illustrates the sequence of such operations, and the corrective maintenance actions that are required when malfunctions are diagnosed.

4.4.5 Counter and Latches.

After the proper RF front end operation is verified, the remainder of the counter and latch circuits may be checked as shown in Figure 4-5.

4.4.6 Display.

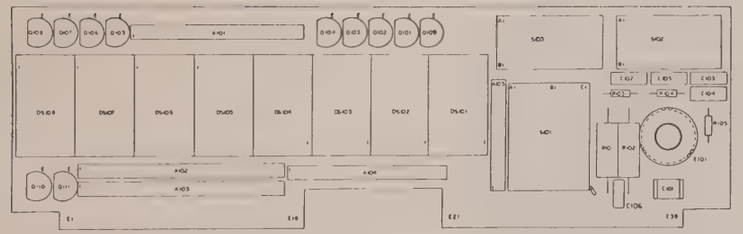
The closed-case analysis should be sufficient to disclose any malfunctioning display elements.

4.4.7 Buttoning Up.

Reassemble case and counter, being careful to use original attaching screw or a substitute of no greater length than the original in order to prevent accidental shorting of display circuits.

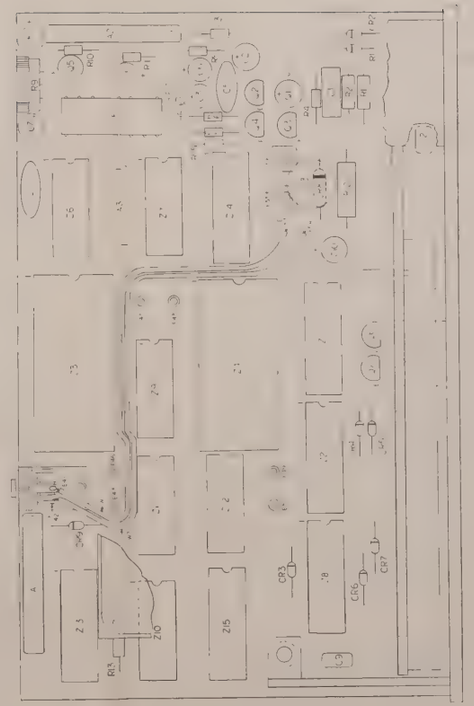
If replacement parts must be ordered, be sure to identify the Data Precision Part No., the circuit reference symbol number, and the revision letter of the PC-board from which the failed component is to be removed. Refer to the attached reference drawing and parts lists.

REFERENCE DRAWINGS
MODEL 585



REFERENCE DESIGNATION	DESCRIPTION	PART NUMBER
A101	RESISTOR NETWORK	22-78-1015
A102, A103	" "	22-78-1016
A104	" "	22-78-1017
A105	" "	22-78-1018
C101	CAPACITOR, .01µf, 200V, 10%	23-142001
C102	" , 8pf, DM5	23-302001
C103	" , 6pf, DM5	23-302000
C104, C105	" , 51pf, DM5	23-302002
C106	" , 180pf, 10%, 200V	23-142002
DS101-DS108	8 DIGIT DISPLAY SET	25-227613
F101	FUSE, PIGTAIL, 1/4 AMP.	25-500010
Q101-Q108, Q110,Q111	TRANSISTOR, 2N5818 (TO-92 STD)	24-235818-A
Q109	" , 2N3906	24-243906
R101	RESISTOR, 51Ω, 1/2W, 5% C.C.	22-035109-C
R102	" , 27Ω, 1/2W, 5% C.C.	22-032709-C
R103	" , 910KΩ, 1/8W, 5% C.C.	22-019149-C
R104	" , 91KΩ, 1/8W, 5% C.C.	22-019139-C
R105	" , 10KΩ, 1/8W, 5% C.C.	22-011039-C
S101	SWITCH, 3 POLE/3 POSITION	25-78-1035-01
S102, S103	" , 2 POLE/3 POSITION	25-78-1034

DISPLAY ASSEMBLY



REFERENCE DESIGNATION	DESCRIPTION	PART NUMBER
A1	RESISTOR NETWORK	22-78-1013
A2	" "	22-78-1014
A3	" "	22-720000
C1	CAPACITOR, 100pf, DM10	23-310023
C3, C6	" , 15µf, 10V	23-441003
C2, C4, C7, C8, C10	" , 47µf, 6.3V	23-441053
C5, C11	" , .001µf, 150V	23-118201
C12	" , .022µf	23-140100
C9	" , 3300pf, 50V	23-140045
C13	CAPACITOR, 68µf, 15V	23-442004
CR1, CR2	DIODE, 5082-2800	24-110004
CR3-CR7, CR9	", 1N4148	24-110001
CR8	", 1N4004	24-104004
J1	JACK	25-700010
Q1	TRANSISTOR, FET, RED DOT	24-48-1074-04
Q2-Q4	" , MPS2369	24-232369
Q5, Q6	" , 2N3904	24-233904
Q7	" , 2N3906	24-243906
R1	RESISTOR, 10Ω,1/4W,5%,C.C.ONLY	22-021009-C
R2	" ,330KΩ,1/4W,5%,C.C.ONLY	22-023349-C
R3	" , 10Ω, 1/4W, 5%	22-021009
R4, R5	" , 75Ω, 1/8W, 5%	22-017509
R6-R8	" , 1KΩ, 1/8W, 5%	22-011029
R9	" , VARIABLE, 2K	22-674202
R10	" , 100Ω, 1/8W, 5%	22-011019
R11	" , 4.7K, 1/8W, 5%	22-014729
R12	" , 15Ω, 1/2W, 5%	22-031509
R13	" , 47KΩ, 1/4W, 5%	22-024739
R15, R16	" , 510Ω, 1/8W	22-015119
Z1, Z2	INTEGRATED CIRCUIT, 4511	24-L14511
Z3, Z4	" " , MC14508 CP	24-L14508
Z5	" " , COUNTER	24-78-1012
Z6	" " , 74LS90	24-E0LS90
Z7	" " , SELECTED	24-78-1023
Z8	" " , COUNTER W/L	24-G06010
Z9	" " , CD4013A	24-L04013
Z10	" " , 74C04N	24-G74C04
Z11	" " , 74LS02	24-E0LS02
Z12	" " , 74LS74	24-E0LS74
Z13	" " , 4020	24-L04020
Z14	" " , MCI 4518CP	24-L14518
Z15	" " , 4017	24-L04017

MAIN ASSEMBLY

DATA PRECISION
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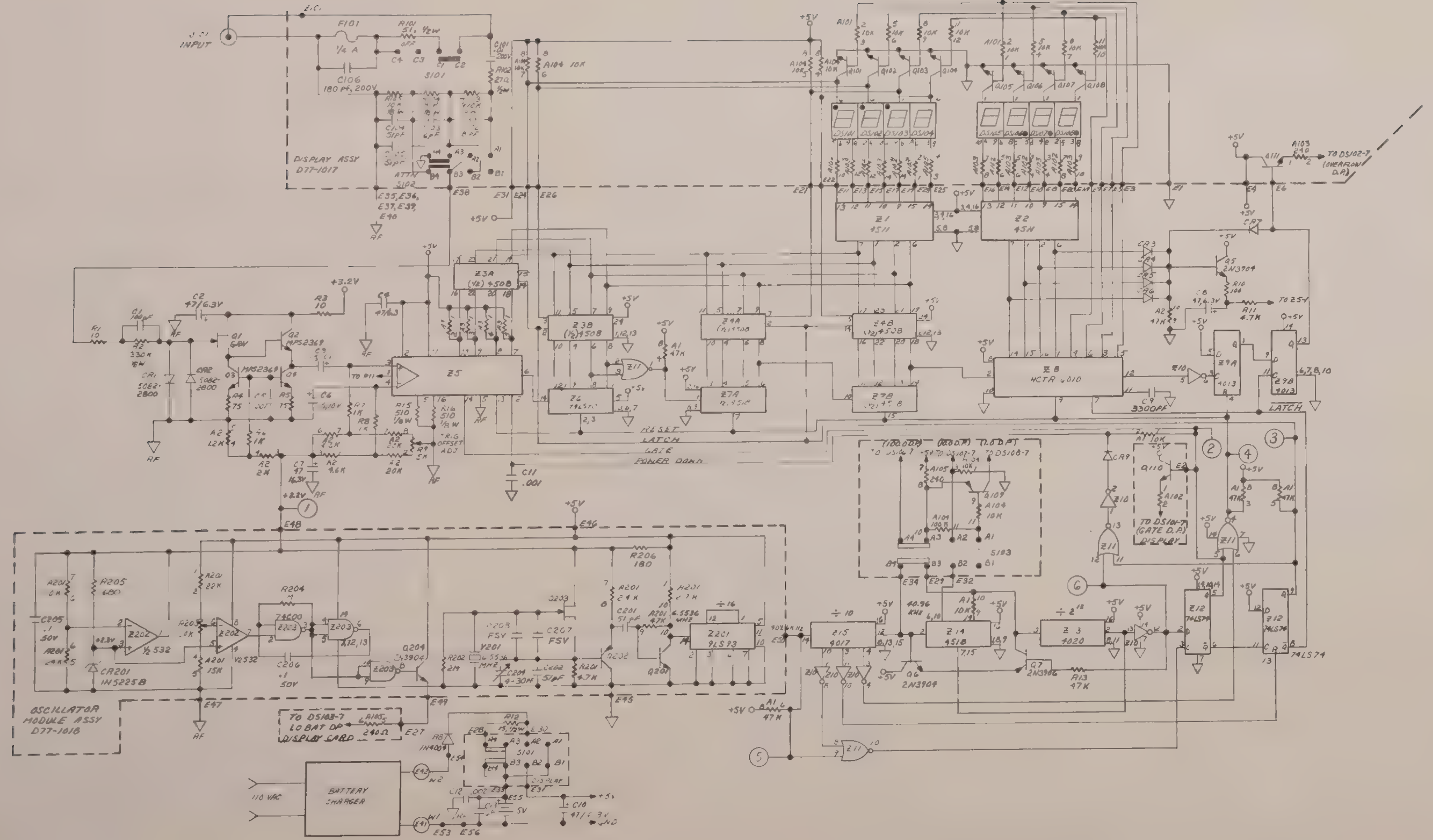
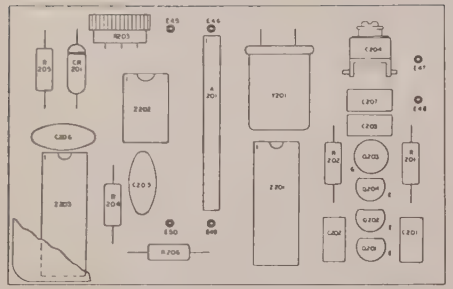

J101
INPUT
F101
1/4 A
R101
51, 1/2W
C106
180 pf, 200V
S101
R102
27Ω
DISPLAY ASSY
D77-1017
ATTN
S102
E35, E36,
E37, E39,
E40
A104 10K
Q101
Q102
Q103
Q104
Q105
Q106
Q107
Q108
DS101
DS102
DS103
DS104
DS105
Z1
4511
Z2
4511
Q111
A103
240
TO DS102-7
(OVERFLOW D.P.)
Q5
2N3904
R10
100
R11
4.7K
TO Z5-1
C8
47/6.3V
Z3A
(1/2) 4508
Z3B
(1/2) 4508
Z4A
(1/2) 4508
Z4B
(1/2) 4508
Z8
HCTR 4010
C9
3300PF
Z9A
4013
Z9B
4013
LATCH
+3.2V
C2
47/6.3V
R3
10
R1
10
C1
100pF
Q1
GAW
Q2
MPS2369
Q3
MPS2369
Z5
TO R11
R15
510
1/8 W
R16
510
1/8 W
TRIG
OFFSET
ADJ
Z6
74LS70
Z7A
(1/2) 4508
Z7B
(1/2) 4508
RESET
LATCH
GATE
POWER DOWN
C11
.001
E48
E46
R206
180
R205
680
R204
1M
74C00
Z203
Z202
1/2 532
CR201
1N5225B
C206
.1
50V
Q204
2N3904
C207
FSV
Y201
6.5536
MHZ
C204
4-30PF
C202
51pF
C201
51pF
Q203
Q202
Q201
÷ 16
Z201
9LS93
OSCILLATOR
MODULE ASSY
D77-1018
E47
E49
E45
TO DS103-7
LO BAT DP
DISPLAY CARD
A105
240Ω
E27
R8
1N4004
R12
15, 1/2W
S101
DISPLAY
BATTERY
CHARGER
110 VAC
E53
E56
C10
47/6.3V
÷ 10
Z15
4017
40.96
KHZ
Z14
4518
÷ 2^12
Z3
4020
Q6
2N3904
Q7
2N3906
R13
47K
Z12
74LS74
Q109
Q110
TO DS101-7
(GATE D.P.)
DISPLAY
S103
E34
E29
E32
Z11



REFERENCE DESIGNATION	DESCRIPTION	PART NUMBER
A201	RESISTOR NETWORK	78-1019
C202, C201	" , 51pf, DM10	23-310016
C203, C207	" , FSV., DM10	
C204	" , VARIABLE 4-30 pf	23-810011
C205, C206	" , .1µf, 50V	23-142003
CR201	DIODE, IN5225B	24-120050
Q201, Q204	TRANSISTOR, 2N3904	24-233904
Q202	" , 2N3906	24-243906
Q203	" , FET (YEL/GRN)	24-48-1014-07
R201	RESISTOR, 4.7kΩ, 1/4W, 5%	22-024729
R202	" , 2MΩ, 1/4W, 5%	22-022059
R203	" , TRIM 10KΩ	22-674103
R204	" , 1MΩ, 1/4W, 5%	22-021059
R205	" , 680Ω, 1/4W, 5%	22-026819
R206	" , 180Ω, 1/4W, 5%	22-021819
Y201	CRYSTAL	78-1020
Z201	INTEGRATED CIRCUIT 74LS93	24-EOLS93
Z202	" " SELECTED	24-48-1089
Z203	" " 74C00	24-G74C00

OSCILLATOR ASSEMBLY

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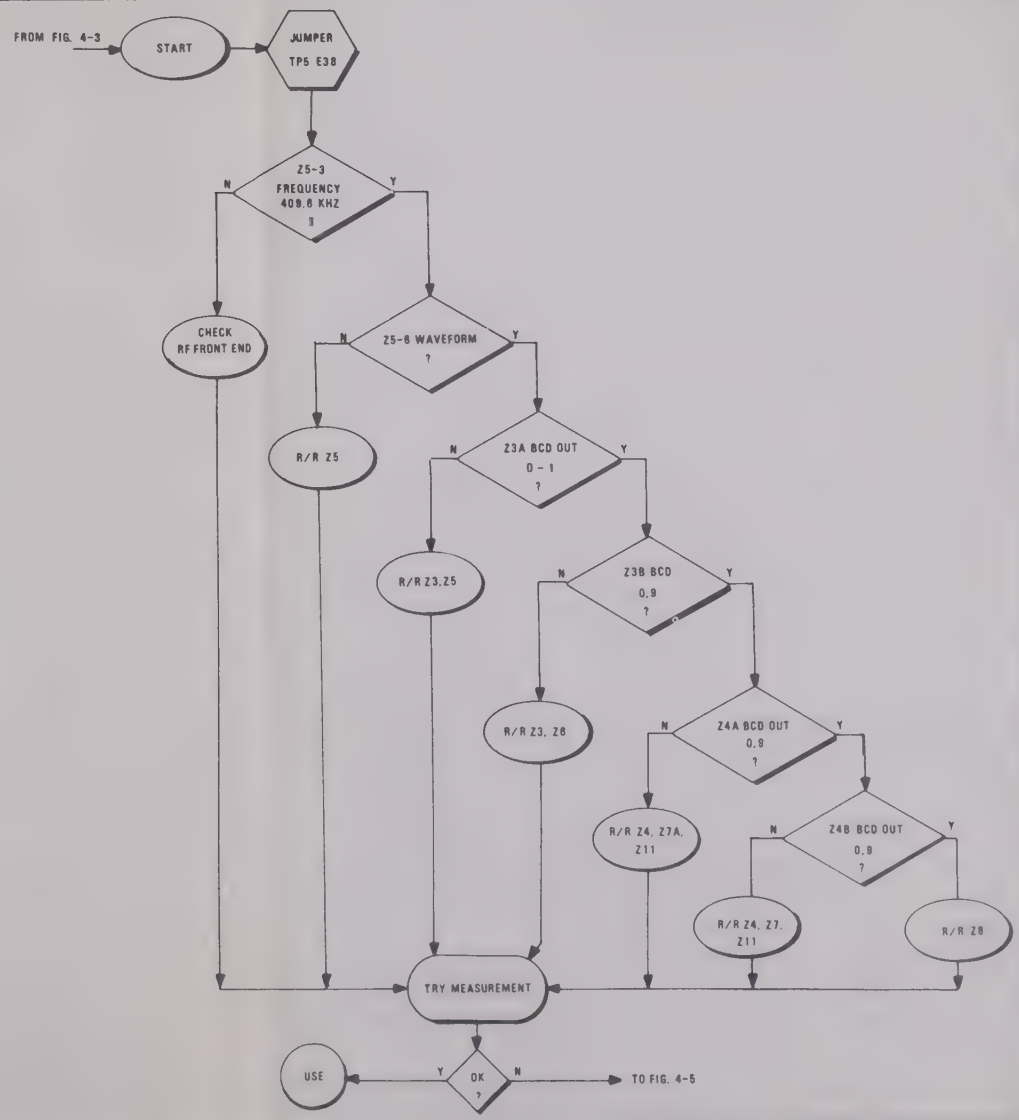
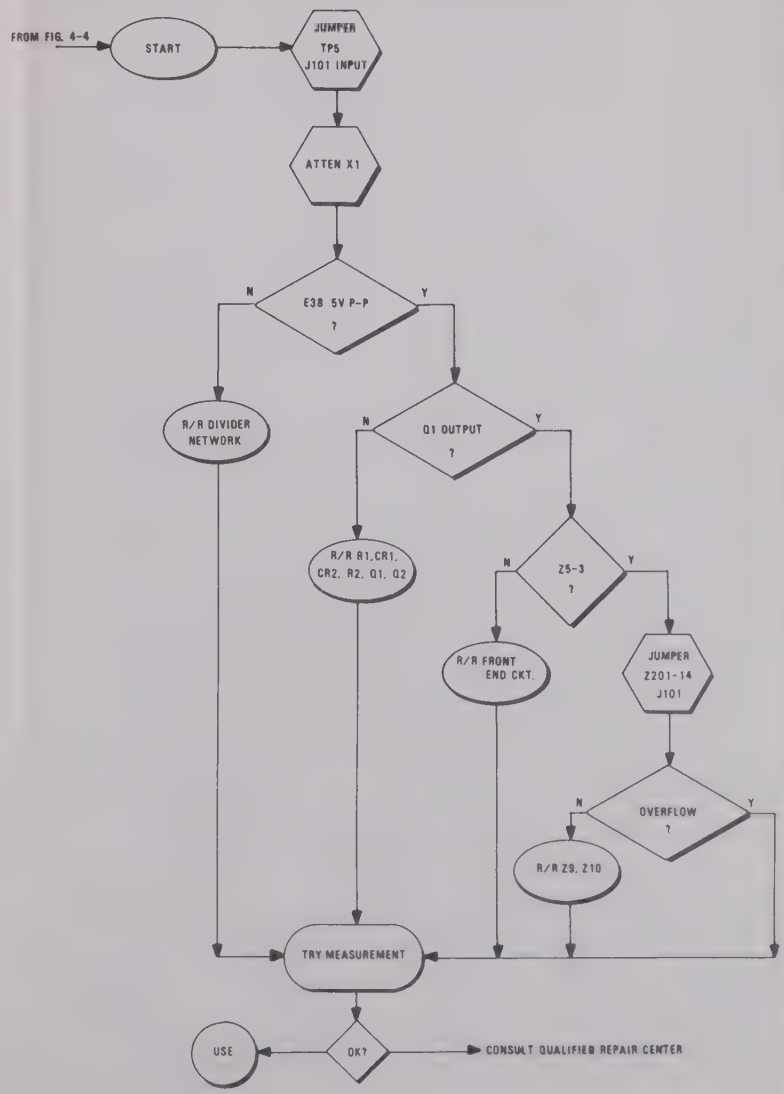
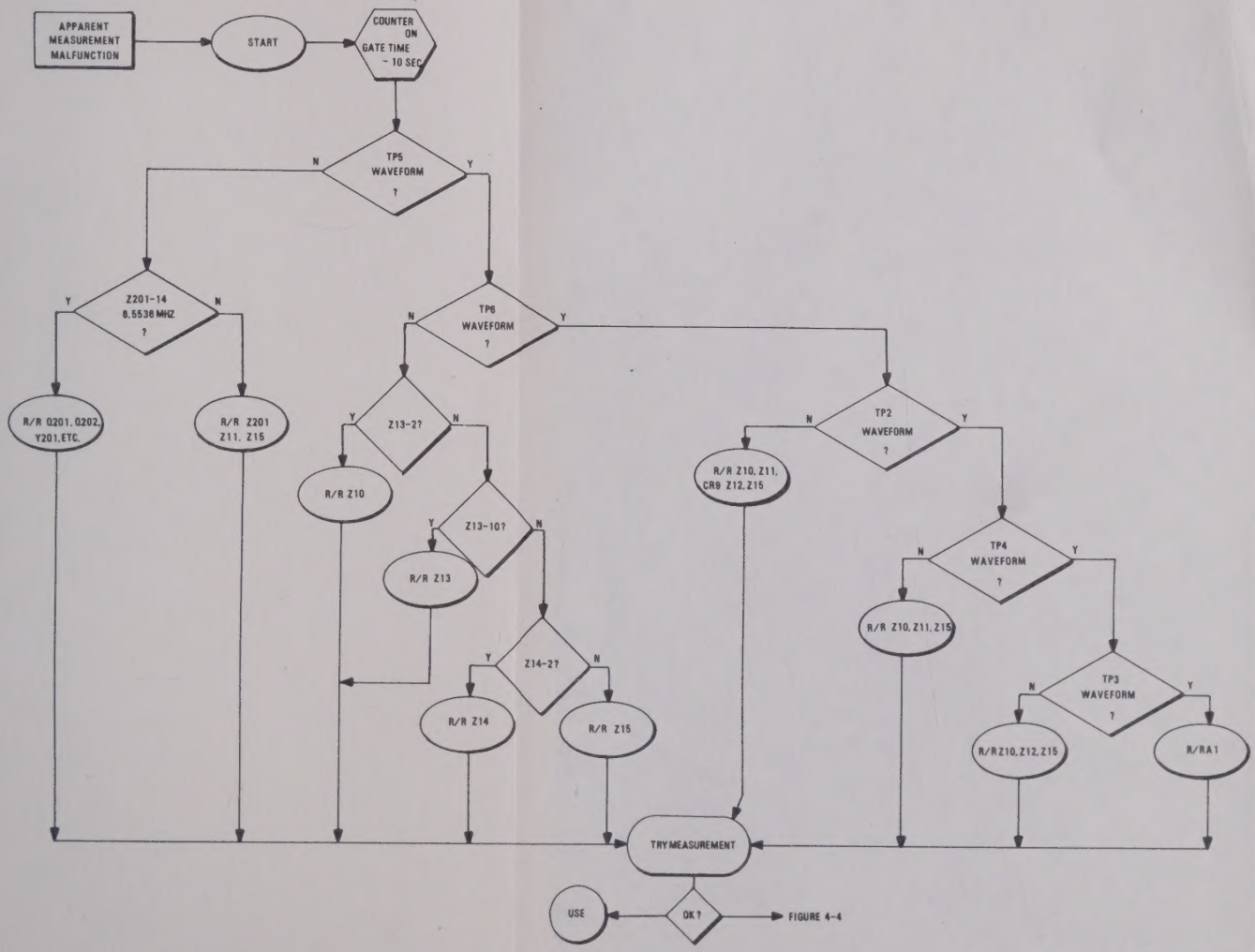


4-3 Timing logic trouble-shooting procedure



4-4 RF front end trouble-shooting procedure



4-5 Counter and latch trouble-shooting procedure

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